

An Overview of Romanian Command and Control Systems

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ABSTRACT

Command and control systems make up as a main tool for combat management. Rapid advances in microelectronics, computers, and materials science have put us where we are today. The Military Equipment and Technologies Research Agency had preoccupations in this area, putted across in the development of C2 systems for air, naval and land forces. This paper proposes some reference points about Romanian command and control systems effectiveness.

Key Words: *Command, Control, Effectiveness.*

1.0 INTRODUCTION

In 1973, Romania fielded first Command and Control system in the radar, missiles, aviation and communication domains.

In the past, those devices pioneered advances in the cybernetic approach but this kind of air defence system could no longer cope with high-density coordinated attacks designated to saturate the defence and to overwhelm both surveillance and C2 systems.

It was clear, from the beginning, that fully automated systems were mandatory from initial target detection through fire control and interceptor vectoring, in a very strong contaminated radio and radar environments.

That is why, in 1974, the former Military Institute for Research and Development approached for the first time in Romania, the Command and Control Systems for Air Defence Forces.

The best achievements in the field were Zonal Air Surveillance Centers (ZASCs) and Fighter Command Centers (FCCs), which were already fielded.

The Military Equipment and Technologies Research Agency (METRA), inherited this good legacy and continued the tradition in the C2 field. The METRA's specialists, in cooperation with other American and Romanian technicians, succeeded in putting into service Romanian Air Sovereignty Operation Center (ASOC) at which, soon after that they connected the radars FPS-117 and the systems mentioned above. The System for Naval Combat Management (on the "Mărășești" frigate) will also become operational.

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2.0 ROMANIAN C2 SYSTEMS

The research efforts made by METRA specialists in C2 field led to some products which should have been integrated into a unitary national system. After 1989 political trends and defence doctrine changed. This led to delays in putting into operational service of manufactured systems.

The main Romanian manufactured C2 systems are the Zonal Air Surveillance Center, the Fighter Control Center and the Naval Combat System.

2.1 Zonal Air Surveillance Center

2.1.1 Destination

The Zonal Air Surveillance Center is designed to integrate 2D analogue radars without plots / tracks generator into a modern surveillance system, using 3D radars with extractors.

2.1.2 Functions

- Surveillance
 - Signal processing from 2D analogue radars and analogue height finder radar;
 - Radar image display.
- **Tracking:** from more sensors simultaneous, with manual initialisation and automatic tracking.
- **Training:** in real or simulated conditions.
- **Back-up:** safe recording of principal data and operator's actions for later analysis.
- **Communications:** provides "order / report" type message traffic with higher echelon and sends zonal air pictures Fighter Control Center.

2.1.3 Components

- Data acquisition device for surveillance radars;
- Data acquisition device for height finder radar;
- Computer for tracking;
- Multi-purpose console;
- Data / voice communication equipment;
- Air conditioning system;
- Independent power supply.

2.1.4 Technical features

- Input data from analogue radars: P-12, P-14, P-18, P-37, 5N87, START-1M;
- Input data from analogue height finder radar: PRV-11, PRV-13, PRV-17;
- Simultaneous connections with:
 - Six 2D radars;
 - Two height finder radar;
 - Fighter Control Center;
- Automatic tracking for 32 tracks.

2.2 Fighter Control Center

2.2.1 Destination

The Fighter Control Center is designed for instrumental and voice command and control of fighter aircraft for long distance interception.

2.2.2 Functions

- Mission control
 - Interception and flight control data processing based on mathematical models;
 - Air picture and flight control data display;
 - Instrumental flight control data composition, codification and transmission;
 - Voice communication for interception control.
- **Training:** in real or simulated conditions.
- **Back-up:** safe recording of the flight control data and operator's actions for later analysis.
- **Communications:** provides "order / report" type message traffic with higher echelon and Zonal Air Surveillance Center.

2.2.3 Components

- Radar data acquisition and processing equipment;
- Height finder radar data acquisition and processing equipment;
- Computer for flight control data processing;
- Multi-purpose consoles;
- Ground to air radio communication equipment;
- Data / voice communication equipment;
- Air conditioning system;
- Independent power supply.

2.2.4 Technical Features

- Instrumental and voice ground flight control for up to 6 fighter aircraft;
- Compatible with the instrumental flight equipment of the: MIG-21, MIG-23, MIG-29 fighter aircraft;
- Simultaneous connections with:
 - Six 2D radars;
 - Two height finder radars;
 - Eight data / voice communication systems;
 - Zonal Air Surveillance Center;
 - Higher echelon.

2.3 Naval Combat System

2.3.1 Destination

The Naval Combat System is designed to provide fight control by an optimised information management based on a radar, sonar, navigation and fire control integration. This system processes and displays data in order to provide a recognized air and maritime picture. Data is collected from surveillance, navigation, sonar and weapons control radar to provide continuous update to a proprietary database maintained on a central computer.

This system is installed on the frigate Marasesti.

2.3.2 Functions

- Data acquisition from sensors;
- Processing and interpretation of the data acquired from sensors;
- Graphical and alphanumerical presentation of the information processed and of the global resulted situation;
- Control of the tactical situation and of missions;
- Fire-control at the firing centres;
- Communications;
- Save / back-up.

2.3.3 Technical and Tactical Features

- Automatic tracking possibilities: 100 targets
- 46 applications of naval kinematics and tactical navigation
- Weapons command-control possibilities: 3 firing centre
- Simultaneous connecting possibilities: naval and air target acquisition radars, navigation radar, navigation sensors, sonar.

3.0 NATO COBP & ROMANIAN C2 SYSTEMS

3.1 Problem Structure

Romanian C2 systems were made in '90-'95 years in a specific geo-political situation. We developed and fielded some C2 systems for air and naval forces that especially focused on providing timely warning of an attack. Previous Romanian studies were valuable source of ideas, data, information, and insight for these systems.

The identification of key C2 systems, doctrine, tactics, techniques and the procedures, the structures and system performance parameters were valid in that period. It is same for the decomposition of the analytic problem into structures, functions, missions, areas, and command levels. In the last years, the structure and character of friendly forces, military chain of command and coalition partners were changed. The consequences upon our C2 systems are significant.

3.2 Human Factors

The benefits from C2 technologies, especially information technologies, are obtained through changes in the training and experience of key personnel. In our case, the organization of training was subsequently to the achievement or implementation of C2 systems, so that we fielded these systems later.

In some C2 systems, we design rules and algorithms for that decision processes requiring the use of “human in the loop”. No complex decision-making or command style is modelled.

3.3 Scenarios

In order to provide combat analysis, we crafted operational scenarios for our C2 systems in testing phase. The contents of these scenarios were related to mission objectives, orders of battle, rules of engagement. The C2 elements we addressed in the scenarios include: decision hierarchy of the units under consideration, information flow, communications processes and capabilities (data update rates, reliability, accuracy). Also, the scenarios took in account different echelons of command and the characteristics of information.

3.4 Measures of Merit

According to Code of Best Practice, the established objectives of the evaluation of our C2 system, using Measures of Merit, we considered to be:

- Establishment of expectation of performance;
- Establishment of the bound of performance of the system.

In order to achieve these purposes, the selected measures we used for these systems could be included only in next three levels hierarchy:

- Measures of Effectiveness (the capacity to create an operating picture of the air or naval battlespace, the range at which the sensors are capable to warning, reaction time);
- Measures of Performance (repair or replacement during operation, response times to users, moving with operational units, communications with other C2 systems, response to request within established times, time to train users);
- Dimensional Parameters.

3.5 Models

Especially for operation purposes, we used the deterministic modelling approach for our C2 systems. Extremely simple models were designed in order to establish the technical capabilities objectives. No other modelling approach was used. These models we created were verified and validated using real experiments.

4.0 CONCLUSIONS

The current military environment, in term of C2 systems, can be characterized by new factors as:

- The managerial and technological advance of the NATO community in the field, which implies significant own efforts, including financial ones, to align our systems with the modern ones, to achieve the competitive and interoperability;
- The C2 systems became the main targets for potential enemy attacks;

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- The modern C2 systems should be based on the same principles and the same operational philosophy;
- The globalisation of the access and information processing;
- The unexpected restrictions imposed by the providers related to information access and the state of the art technologies;
- The omnipresence of the decision making act, unconditioned by time or space;
- Almost real time reaction of military systems.

The cumulative impact of the above mentioned factors shall influence the process of designing, developing and testing C2 systems.

The access to the state of the art technologies and the cooperation with NATO and PfP countries underlined the necessity to develop Romanian systems in order to achieve the interoperability with the similar NATO/PfP systems.

In order to develop C2 systems able to supply intelligent support for commanders, new methods should be developed to recognize the analytic request importance. The recent emphasis on prototyping is consistent with evolutionary development requirements and is likely to become an essential step in the C2 systems design process. The evolutionary development is a concept that originates in high technology, doctrine, cost-effectiveness relationship and “try-before-buy” strategy. The relationship between the doctrine and C2 systems development must be permanently examined.

The evaluation must be the first step and the tests must be gradually run as long as our C2 systems are developed, but not after they are already in production. Certainly, one of the problems is the trust we have in C2 simulation environment to test our systems, these environment may or not may be enough closed to the real conditions in order to make more credible the evaluation.

The evaluation of our C2 systems is impossible without addressing the way they can interact with our partner systems (future allies) and how they can affect the potential enemy systems.

In conclusion, it should be mentioned that the developing of Romanian C2 systems and the procurement of other systems represent a priority of Romanian Army, that being the reason why it exists a very favourable climate for new initiatives and concepts in this field.

Finally, we like to point following aspects:

- The solutions for more rapid improvements to our C2 capabilities are not simple and will require an important financial effort;
- C2 is a military operational problem that will not be solved without a deep and persistent involvement in the requirements, resource allocation, acquisition, and testing process;
- Inherent risks in the increasing dependence of combat doctrine upon survivable C2 must be demonstrated to commanders by simulations and exercises that place realistic stress upon C2 systems;
- Evolutionary acquisitions and the leveraging of commercial information systems technology are proven means to satisfy most military C2 requirements and they are probably the only ways to lower costs and produce near term improvements substantially.

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6.0 LIST OF ACRONYMS

ASOC	Air Sovereignty Operation Center
C2	Command and Control (Systems)
FCC	Fighter Control Center
METRA	Military Equipment and Technologies Research Agency
ZASC	Zonal Air Surveillance Center

AUTHOR BIOGRAPHY

Stefan Cantaragiu is General Manager of the Military Equipment and Technologies Research Agency from 1999. He is an expert in radiotechnics and radiocommunications and has a Ph. D. from Military Technical Academy, Bucharest. He has numerous works in the field of research management and radiotechnics (microwaves circuits, antennas and propagation).

Adrian Pascu is a scientific researcher at METRA. He has published two papers in radar field and three papers concerning data quality for informatics systems. He's current works are in the field of Romanian C2 systems.

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